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C3V
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(71) Applicant
Chisso Corporation
(Japan),
6—32 Nakanoshima 3-
chome, Kitaku, Osaka,
Japan
(72) Inventors
Taizo Sugihara,
Yasuhiko Furukawa
(74) Agent and/or Address for
Service
Marks and Clerk,
57/60 Lincoln's Inn Fields,
London WC2A 3LS

(54) Hot-melt adhesive fibres

(57) Hot melt-adhesive fibers for non-woven fabrics are provided which (i) comprise a polyethylene resin composition (C) alone, consisting of 50 to 100% by weight of a polyethylene (A) having a density of 0.910 to 0.940 g/cm³ and a Q value ($Q=M_w/M_n$) of 4.0 or less and 50 to 0% by weight of a polyethylene (B) having a density of 0.910 to 0.930 g/cm³ and a Q value of 7.0 or more, or (ii) are composite fibers which contain said composition (C) as one of the composite components and in which said composition (C) forms continuously at least a part of the composite fiber surface. The composite fibres may be obtained by co-spinning with, for example, high density polyethylene, polypropylene or polyester.

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SPECIFICATION

Hot-melt adhesive fibers

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to hot-melt adhesive fibers and more particularly it relates to hot-melt adhesive fibers comprising a specified polyethylene resin composition.

Description of the Prior Art

In the production of non-woven fabrics, the process of adhering fabrics to one other includes a process by way of interfilamentary entanglements such as needle punching process and a process by way of various adhesives (binders).

Further, for non-woven fabrics in hygienic, medical or similar application fields having a greatly increasing demand in recent years, specific features such as soft feeling, light weight per unit area and high strength have been required, and non-woven fabrics made according to binder process have been mainly employed therefor. As this binder process, a process of immersing a web in an adhesive solution (or emulsion) or a process of spraying the solution onto a web has been mainly employed. Recently, however, for reducing the energy cost for solvent removal and improving operational environment, a process of mixing powdery or fiber-like solids having a relatively low melting point with stock fibers for non-woven fabrics and bringing the mixture into interfilamentary adhesion by heat treatment has come now to be very often employed. Particularly the fiber-like binder has such superior specific features that it can be uniformly mixed with fibers constituting non-woven fabrics, it makes sheet-making easy and provides a good yield.

Specific features required for the binder fiber for non-woven fabrics in the above-mentioned application fields include that

(1) the fiber should have a melting point of 100°C or higher, for keeping heat-resistance of non-woven fabrics;

(2) the fiber should have preferably a melting point of 140°C or lower, for keeping the heat treatment cost for hot adhesion lower;

(3) the fiber itself should be also soft and have a denier as fine as about 1.5 to 6 d/f, for imparting soft feeling to non-woven fabrics; etc.

Hot-melt adhesive binders so far used include those of low melting polyester, polypropylene or polyethylene as stocks, but only polyethylene among them may nearly satisfy the above-mentioned requirements. However, polyethylene employed usually in the form of fibers is high density polyethylene having a density of 0.950 to 0.970 and has such drawbacks that it has a high crystallinity and non-woven fabrics obtained by hot-melt adhesion treatment are liable to have a hard feeling. On the other hand, low density polyethylene has low rigidity and soft feeling may be expected from it, but it is inferior in spinnability and stretchability; i.e. when it is subjected to single spinning, only monofilament as thick as about 100 d/f or more can be obtained and hence the above-mentioned requirement of 1.5 to 6 d/f cannot be satisfied; thus it has been used mainly in the form of powder.

SUMMARY OF THE INVENTION

The object of the present invention is to provide hot-melt adhesive fibers having no such drawbacks of polyethylene.

The present invention which can attain the above-mentioned object resides in the following hot-melt adhesive fibers comprising singly or as one of composite components of composite fibers, a polyethylene resin composition specified below:

Hot-melt adhesive fibers comprising a polyethylene resin composition (C) alone, consisting of 50 to 100% by weight of a polyethylene (A) having a density of 0.910 to 0.940 g/cm^3 and a Q value ($Q=M_w/M_n$) of 4.0 or less and 50 to 0% by weight of a polyethylene (B) having a density of 0.910 to 0.930g/cm^3 and a Q value of 7.0 or more based on said composition, or composite fibers which contain said composition (C) as one of the composite components of said composite fibers and in which said composition (C) forms continuously at least a part of the fiber surface of said composite fibers.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The polyethylene (A) used in the present invention can be obtained by subjecting ethylene together with an α-olefin of 4 to 8 carbon atoms as a copolymerization component to coordinate, anionic polymerization in the presence of a catalyst, and can be choiced from among those which are commercially available under a name of L—LDPE. The polyethylene (B) used in the present invention can be obtained by polymerizing ethylene according to radical reaction under a high pressure of 1,000 to 3,000 atm in the presence of oxygen or a peroxide, and can be choiced from among those which are commercially available under a name of LDPE.

The reason that the concentration of the polyethylene (A) in the polyethylene resin composition (C) is limited to 50 to 100% by weight and the concentration of the polyethylene (B) is limited to 50 to 0% by weight in the present invention is that if the concentration of the polyethylene (A) in the resin

composition (C) is less than 50% by weight (i.e. the concentration of the polyethylene (B) exceeds 50% by weight), the spinnability and stretchability of the resin composition (C) becomes inferior to make a stabilized spinning operation impossible.

As to the blending of the polyethylene (A) with the polyethylene (B), any of known blending methods usually employed for blending thermoplastic resins may be employed. Examples of the blending methods are a method of blending powdery polyethylenes (A) and (B) by means of ribbon blender or Henschel mixer and further a method of kneading and granulating powdery or pellet-form polyethylenes (A) and (B) by means of an extruder. It is possible to add stabilizer, coloring agent, filler, etc. usually added to polyethylene, to the polyethylene resin composition (C), so long as it does not fail to satisfy the object of the present invention.

The thus obtained polyethylene resin composition (C) can be subjected either to single spinning by itself or to composite spinning together with other fiber-formable resins.

Examples of such other fiber-formable resins to be subjected to composite spinning are high density polyethylene, polypropylene, polyester, etc. The composite shape may be either of the side-by-side type or sheath and core type, and for making use of the hot-melt adhesive effectiveness of the polyethylene resin composition (C), the resin composition (C) should be so arranged in the case of side-by-side type that the composition (C) can form continuously at least a portion of the fiber surface, and in the case of sheath and core type that the composition (C) can constitute the sheath component of the composite fibers.

In the case of single spinning, when spinning is carried out at a spinning temperature of 200 to 300°C, a draft ratio of 400 to 1,200, and a draw rate of 500 to 1,000 m/min, and stretching is carried out at a stretch temperature of 60° to 110°C and a stretch ratio of 2 to 6 times, it is possible to obtain hot-melt adhesive fibers of 1.5 to 6 deniers in stabilized state. In the case of composite spinning, although spinning and stretch conditions vary depending on the partner composite component, the spinning temperature on the side of the polyethylene resin composition (C) is suitably in the range of 200° to 300°C, and the spinning and stretch conditions other than the spinning temperature, of the partner component may also be established according to the above conditions in the case of single spinning.

The hot-melt adhesive fibers of the present invention can be used as a binder for non-woven fabrics, by blending them with non-woven fabric-constituting fibers and shaping the blend according to wet paper-making process, carding web process or the like, as in the case of so far known binder fibers, followed by heat treatment at a temperature of 130° to 140°C by means of hot air, super-heated steam, infrared ray, heated rolls or the like. As for the non-woven fabric-constituting fibers, one or more kinds of natural fibers such as pulp, cotton, wool, etc. and chemical fibers such as viscose rayon, polyolefin fibers, polyester fibers, polyamide fibers, etc. can be adequately selected for use. The amount of the hot-melt adhesive fibers of the present invention to be blended with the non-woven fabric-constituting fibers is required to be 10% by weight or more based on the fibers after blending, and if a greater strength of non-woven fabric is required, 30% by weight or more is preferred.

In the case where the hot-melt adhesive fibers of the present invention are composite fibers, a web is prepared from the fibers alone, followed by subjecting the web to a heat treatment at a temperature of the melting point of the lower melting component (the polyethylene resin composition (C)) or higher, but lower than the melting point of the higher melting component (the partner component in the composite fibers), whereby a non-woven fabric can be obtained without blending the fibers with other kind of fibers.

The hot-melt adhesive fibers of the present invention have such various superior characteristics that since they are fibrous, it is possible to easily effect a uniform blending with other kinds of fibers, and moreover since they have a small denier, their adhesion points are small and also since they have a low rigidity, it is possible to obtain a non-woven fabric having soft-feeling, and further since they have a low melting point, they exhibit a strong adhesion at a relatively low temperature of heat treatment whereby energy cost can be reduced.

The present invention will be further described by way of Examples and Comparative examples. The tests and evaluation methods employed therein are as follows:

Spinning test

Single spinning:

Pellets of definite polyethylene (A) and polyethylene (B) were blended in a definite ratio by weight by means of a tumbler mixer and fed into an extruder for spinning. Spinning was carried out through a spinning nozzle having 240 holes and at an extruder rate of about 130 g/min. to obtain unstretched filaments, followed successively by stretching in a definite ratio according to heated roller process.

Composite spinning:

Polyethylene (A) and polyethylene (B) were blended in the same manner as above, and the blend was fed to one of two extruders for composite spinning. The extruder rates of the respective composite components were adjusted in accordance with definite composite ratios, followed by spinning and

stretching under the same conditions as in the case of a single spinning except that a spinneret of side by side type or sheath and core type was used.

Spinnability evaluation:

Spinnability was evaluated by means of the number of times of fiber breakage of unstretched filaments per hour, and designated as follows:

0 time: ⊙, one time: o, two times: Δ, three times or more: x.

Stretchability evaluation:

In continuous stretching operation for one hour, filaments having no occurrence of single filament breakage were evaluated to be excellent (designation: ⊙); filaments having three times or less occurrences of the breakage, to be good (designation: o); and filaments having many times occurrences of the breakage and also having one time or more occurrences of operation stop due to coiling of filaments around stretching rolls, to be bad (designation: x).

Non-woven fabric test

Calendering roll process:

The fibers and heat melt-adhesive fibers for constituting a non-woven fabric were blended together and the blend was subjected to a flat carding to prepare a web having a definite weight per unit area, which was then passed through between metal rolls each having a diameter of 200 mm under a pressure of 2 Kg/cm, heated to a definite temperature, at a ratio of 6 m/min. to prepare a non-woven fabric.

Drying process:

A web was prepared in the same manner as in the case of calendering process, and the web was heated in a dryer of hot air-circulation type adjusted to a definite temperature, for 5 minutes, to prepare a non-woven fabric.

Paper-making process:

From blended raw material fibers were made a wet sheet by means of a hand paper-making testing machine and the sheet was passed through a Yankee dryer of 30 cm in diameter having a definite temperature, at a rate of 1 m/min., followed by drying and heat treatment to prepare a non-woven fabric.

Tensile strength:

This was measured according to testing method for tensile strength and elongation of JIS L1085 (testing method for padding cloth of non-woven fabric), i.e. by gripping a sample of 5 cm wide and 20 cm long and pulling it through an interval of 10 cm at a rate of pulling of 30 ± 2 cm/min.

Feeling evaluation:

Feelings of non-woven fabrics of the respective examples and those of contrast examples wherein the heat melt-adhesive fibers of the present invention were replaced by a polyvinyl acetate adhesive were evaluated by an organoleptic test carried out by 5 panellers (3 men and 2 women). When a non-woven fabric of an example was judged to have a better feeling than that of contrast example, the former was designated as ⊙; when judged to be similar to the latter, the former, as o; and when judged to be inferior, the former, as x.

EXAMPLES 1—4 AND COMPARATIVE EXAMPLES 1—4

Various kinds of polyethylenes (A) and polyethylenes (B) were blended in different blending ratios as shown in Table 1—1 to prepare polyethylene resin compositions (C), and heat melt-adhesive fibers were prepared from these compositions under spinning and stretching conditions as shown in Table 1—2. Evaluations of the spinnability and stretchability of the respective polyethylene resin compositions are shown in Table 1—2.

The above heat melt-adhesive fibers were cut into short fibers which were then blended with other kind of fibers, followed by heat treatment to obtain non-woven fabrics. Blending conditions, non-woven fabric-making conditions and characteristics of the resulting non-woven fabrics are shown in Table 1—3.

TABLE 1—1

Experiment No.	Polyethylene (A)			Polyethylene (B)			Blending ratio	Remarks
	Density	MI	Q	Density	MI	Q	A : B	
1	0.920	25	2.82	—	—	—	100 : 0	Example 1
2	0.920	25	2.82	0.920	23	7.57	70 : 30	Example 2
3	0.920	25	2.82	0.920	23	7.57	50 : 50	Example 3
4	0.920	25	2.82	0.920	23	7.57	40 : 60	Comparative example 1
5	0.924	20	3.83	0.920	23	7.57	60 : 40	Example 4
6	0.937	20	5.23	0.920	23	7.57	60 : 40	Comparative example 2
7	0.950	15	3.90	—	—	—	100 : 0	Comparative example 3
8	—	—	—	0.920	23	7.57	0 : 100	Comparative example 4

TABLE 1—2

Experiment No.	Spinning conditions				Stretching conditions			
	Spinning temperature °C	Draft rate	Denier of unstretched filament d/f	Spinnability evaluation	Stretching temperature °C	Stretch ratio	Denier of stretched filament d/f	Stretchability evaluation
1	255	462	13.8	◎	100	4.6	3.0	◎
2	255	1068	6.0	◎	100	2.0	3.0	◎
3	255	462	13.8	o	100	2.3	6.0	o
4	255	462	13.8	x	—	—	—	—
5	270	638	10.0	o	110	5.0	2.0	o
6	270	648	10.0	x	—	—	—	—
7	280	479	13.8	◎	100	4.6	3.0	◎
8	210	462	13.8	x	—	—	—	—

TABLE 1—3

Experiment No.	Heat melt-adhesive fibers d x mm	Kind of other fibers d x mm	Blending ratio PE : another	Heat treatment		Weight per unit area g/m²	Tensile strength Kg/5 cm	Feeling evaluation
				Process	Temperature °C			
1	Example-1 3 x 64	PET 1.5 x 38	40:60	Calendering rolls	140	20	4	⊙
2	Example-2 3 x 6	Rayon 2 x 6	30:70	Yankee dryer	135	15	2	o
3	Example-3 6 x 51	PET 6 x 51	20:80	Calendering rolls	130	20	3	⊙
4	—	—	—	—	—	—	—	—
5	Example-4 2 x 38	PP 3 x 64	30:70	Dryer	145	100	5	⊙
6	—	—	—	—	—	—	—	—
7	Compar. ex.-3 3 x 64	PET 1.5 x 38	40:60	Calendering rolls	145	20	5	x
8	—	—	—	—	—	—	—	—

PET: Polyester PP: Polypropylene

EXAMPLES 5—9 AND COMPARATIVE EXAMPLES 5—7

Various kinds of fiber-formable resins were combined with polyethylene resin compositions (C) consisting of various kinds of polyethylenes (A) and polyethylenes (B) to obtain various hot-melt adhesive composite fibers. Compositions of the polyethylene resin compositions (C), composite components combined therewith, composite types and composite ratios are shown in Table 2—1 and spinning and stretching conditions as well as spinnability and stretchability evaluations are shown in Table 2—2.

The above hot-melt adhesive composite fibers were cut into short fibers which were then blended with other fibers and subjected to heat treatment to obtain non-woven fabrics. Blending conditions, non-woven fabric-making conditions and characteristics of the resulting non-woven fabrics are shown in Table 2—3.

TABLE 2—1

Experiment No.	Polyethylene resin composition (C)						Blending ratio	Composite component (D)	Composite type	Composite ratio (C):(D)	Remark
	Polyethylene (A)			Polyethylene (B)							
	Density	MI	Q	Density	MI	Q	(A):(B)				
9	0.935	40	2.73	—	—	—	100:0	PP*1	side by side	55:45	Example 5
10	0.920	25	2.82	0.920	23	7.57	70:30	PP*1	sheath and core	60:40	Example 6
11	0.920	25	2.82	0.920	23	7.57	50:50	PET*4	sheath and core	50:50	Example 7
12	0.920	25	2.82	0.920	23	7.57	60:40	PP*2	side by side	70:30	Example 8
13	0.920	25	2.82	—	—	—	100:0	PE*3	side by side	50:50	Example 9
14	0.920	25	2.82	0.920	23	7.57	40:60	PET*4	sheath and core	40:60	Compar. ex. 5
15	—	—	—	0.937	20	5.0	0:100	PP*1	side by side	55:45	Compar. ex. 6
16	0.950	15	3.9	—	—	—	100:0	PP*1	side by side	55:45	Compar. ex. 7

PP*1: Propylene homopolymer, MFR = 5.3
PP*2: Ethylene-propylene copolymer, MFR = 7.0
PE*3: High density polyethylene, MI = 10
PET*4: Polyester, MP = 255°C

TABLE 2—2

Experiment No.	Spinning conditions					Stretching conditions		
	Spinning temperatre °C PE/another	Draft rate	Denier of unstretched filament d/f	Sinnability evaluation	Stretching temperature °C	Stretch ratio	Denier of stretched filament d/f	Stretchability evaluation
9	200/300	462	13.8	◎	100	4.6	3.0	◎
10	220/300	1042	6.0	o	100	2.0	3.0	o
11	220/350	1042	7.5	◎	95	3.75	2.0	o
12	220/280	473	13.8	◎	100	2.3	6.0	o
13	220/230	365	18.0	◎	105	6.0	3.0	o
14	220/350	1111	7.5	△	95	3.75	2.0	x
15	220/300	473	13.8	x	—	—	—	—
16	220/300	473	13.8	o	110	4.6	3.0	o

PE: Polyethylene resin composition
Another: Another composite component

TABLE 2—3

Experiment No.	Heat melt-adhesive fibers d x mm	Kind of other fibers d x mm	Blending ratio PE : another	Heat treatment		Weight per unit area g/m²	Tensile strength Kg/5 cm	Feeling evaluation
				Process	Temperature °C			
9	Example-5 3 x 64	PET 2 x 51	50:50	Calendering rolls	140	30	8	◎
10	Example-6 3 x 10	Rayon 2 x 6	40:60	Yankee dryer	130	15	4	◎
11	Example-7 2 x 6	PET 2 x 10	30:70	Yankee dryer	130	20	4	o
12	Example-8 6 x 64	Wool	20:80	Dryer	145	100	7	◎
13	Example-9 3 x 51	Acetate 4 x 51	30:70	Calendering rolls	140	40	7	o
14	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—
16	Compar. ex.-7 3 x 64	PET 2 x 51	50:50	Calendering rolls	140	30	9	x

As apparent from the results of the above examples, the hot-melt adhesive fibers of the present invention are superior in spinnability and stretchability, and when the fibers are used as a binder, it is possible to obtain a non-woven fabric having a superior strength of non-woven fabric and feeling, with economical advantage.

CLAIMS

1. Hot-melt adhesive fibers comprising a polyethylene resin composition (C) alone, consisting of 50 to 100% by weight of a polyethylene (A) having a density of 0.910 to 0.940 g/cm^3 and a Q value ($Q=M_w/M_n$) of 4.0 or less and 50 to 0% by weight of a polyethylene (B) having a density of 0.910 to 0.930 g/cm^3 and a Q value of 7.0 or more based on said composition, or composite fibers which contain said composition (C) as one of the composite components of said composite fibers and in which said composition (C) forms continuously at least a part of the fiber surface of said composite fibers.

2. Hot-melt adhesive fibers according to claim 1 wherein another component to be made composite with said composition (C) is polypropylene.

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